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INVESTIGATION OF METHODS OF DETERMINING TERRAIN CONDITIONS BY INTERPRETATION OF VEGETATION FROM AERIAL PHOTOGRAPHY

TECHNICAL REPORT No. 6

Part II. Interpretation of Vegetation on Aerial Photographs of the Chesapeake Bay, a Type of Inland Shores Summarizing and Supplementing Technical Report No. 1

Office of Naval Research
Project No. 257002
Contract N6-onr-25504

Arctic Institute
Catholic University of America

January 31, 1953

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A contract between
the Amphibious Branch Office of Naval Research and the Arctic Institute Catholic University of America

Monitored by
Research and Analysis Division
Photographic Interpretation Center
Naval Receiving Station

Office of Naval Research
Project No. 257002
Contract N6-onr-25504

Hugh O'Neill, Chief Investigator

and

Arthur Barwick, Arthème Dutilly, Maximilian Duman, Herbert Hanson, Robert Heller, Ernest Lepage, William Nagel, R. J. O'Neill, Richard Shamp, Edward Steigerwaldt, Harold Young and Vincent Waldron.

ARCTIC INSTITUTE
Catholic University of America
January 31, 1953

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TECHNICAL REPORT No. 6

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SUMMARY

The results of Technical Report No.1 have been summarized and supplemented in this Report No.6. Repetition of Technical Report No.1 has been avoided except where absolutely necessary. This required an occasional reference to Technical Report No.1, but these references have been kept to a minimum.

The principal additions to Technical Report No.1 are as follows:

1. A rapid, original "scanning" method of deducing terrain conditions from even small-scale air and/or ground photographs, using both landforms and associated patterns of vegetation, whereby the landforms indicate the general conditions and the vegetative patterns, the details of the terrain conditions within each type of landform.

2. This method applies to the interpretation of much, if not all, of the inland shores of the Chesapeake Bay and to a considerable extent to inland shores, drowned rivers and embayments elsewhere, e.g. the Delaware, the Hudson and the St. Lawrence; and with adaptations to the Baltic Sea, the North Sea and its fjords in Scotland and Norway, etc.

3. Keys for the identification of landforms and their related zones of vegetation are given in Section 5; tables for deducing terrain conditions from the identifications are given in Section 7; while Section 6 explains how to make such deductions.

4. When it is of practical importance to identify individual trees, and the photographs are of good quality and of appropriate scale, the interpreter is referred to Technical Report No.1.

5. A means of determining whether a river is drowned or not is given (pages 3, and 7 of introduction).

6. Five diagrams (section 5, pages 4, 5, 6, 7, 8), six contact large-scale air oblique photographs, (1/5, 10/5, 11/5, 12/5, 14/5, 12/6) and five plates (Plates VI to X) of ground and air photographs illustrate the recognition of zones of vegetation on landforms (coves and points).

7. The effect of differences in chemical composition of the soil on the vegetation it supports is discussed and illustrated in the introduction.

8. In particular, the effect of soil from weathered serpentine upon the vegetation is discussed and illustrated on Plates I to V.

9. The military significance of the high and low banks of the Bay is mentioned (introduction page 15) and illustrated especially on Plates VII and VIII.

10. Air photographs taken when there is snowfall on the shores of the Bay does not, as is commonly thought, blot out all possibility of interpreting terrain conditions but on the contrary, increases the information the interpreter can deduce especially as regards marshes. Observations made in the Bay area were extended to Canada and are treated as generalization in Part I under Snow-fall Series illustrated by 5 plates.

11. Observations on the marshes in the "Bay" and on snow-covered terrain led the Project Director to consider both of these as a very sensitive medium on which military movement cannot be made without leaving traces which are readily recorded and even more readily interpreted on air photographs. Because these observations were expanded into generalizations probably valid the world-over, they are described in detail in Part I. It should be stated here that mine-laying, setting barbed wire, or any military movement in a cat-tail marsh is indelibly betrayed on a vertical photograph.

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LIST OF PLATES IN PART II

Serpentine Series

I Stereo Ground Panchromatic Photographs. Barrens, Delight, Md.

II Stereo Ground Panchromatic Photographs. Barrens, Delight, Md.

III Stereo Ground Panchromatic Photographs. Barrens, Delight, Md.

IV Ground Photographs. Serpentine areas. New Caledonia.

V Ground Photographs. Serpentine areas. New Caledonia, Hudson Bay and Maryland.

VI Stereo Air Photographs with Stereo Ground Photographs to Match. Landforms and Related Vegetation, Chesapeake Bay.

VII Stereo Air Photographs with Stereo Ground Photographs to Match. Landforms and Related Vegetation, Chesapeake Bay.

VIII Ground Stereo Photographs. Steep Banks, Cypress Swamp and a Dry Point, Chesapeake Bay.

IX Ground Stereo Photographs. Mouth of Creek Filled by a Sand Bar with Typical Associated Vegetation, Chesapeake Bay.

X Ground Photographs Showing Typical Zones of Vegetation in a Cove with Brackish Water, Chesapeake Bay.

LIST OF SIX OBLIQUE PANCHROMATIC AIR PHOTOGRAPHS

ILLUSTRATING TERRAIN CONDITIONS

ON INLAND SHORES IN EMBAYMENTS

ALL TAKEN BY U.S. NAVAL RECEIVING STATION

Within the Space of 12 Minutes, Sept. 15, 1949.

Large scale photographs illustrating landforms and associated types of vegetation as indicators of landing and other terrain conditions.

1/5 Four Points and Connecting Banks. Showing a LANDFORM, a Typical Point with Associated VEGETATION, Both Indicating Sand.

10/5 Two Coves with Associated Marsh and Swamp, Both LANDFORM and Type of VEGETATION Indicating Deep, Soft Mud.

11/5 Three Coves with Associated Zonation of Vegetation as Indicators of the Depth and Width of the Mud at the Base of Banks.

12/5 Detail of a Cove Shown on 11/5 Showing a Cat-tail Marsh. Estimation of the Depth of Shallow Water. A Marsh Forming Rapidly by Deposition of Silt.

14/5 Detail of a Cove Shown on 11/5 Showing Cat-tail MARSH Meeting a SWAMP of Black Willows and Alders.

12/6 Two Points Forming Across the Mouth of a Small Creek, the First Stage in the Formation of a Marsh with Little or no Silting in the Creek but with Deposition of a Sand Bar at the Mouth of the Creek by the River. Steep Banks in the Background.

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INTRODUCTION

The object of this Part II is to summarize and supplement Technical Report No. 1, "An Experimental System of Keys for the Interpretation of Vegetation on Aerial Photography. Test Location: Chesapeake Bay", published in December, 1950. Accordingly, the information accumulated in the past two years has been added to a summary of Technical Report 1, but repetition of the information and keys in Technical Report 1 is avoided here as far as practical.

THE CHESAPEAKE BAY REGION AS A TEST LOCATION.

The Chesapeake Bay region was chosen as a Test Location for the following reasons:

1) The research facilities in this region are exceptionally good, because the vegetation, the soils and subsoils, terraces, beaches, sediments, climate, weather, and the water of the Bay itself have been studied intensively by many agencies and individuals for a long time. Most of the results of this work have been published and are readily available. Considerable research is in progress, much of which has a direct or indirect bearing on this study. For example, Dr. George Carter published a month ago the results of his study of the soils and terraces of the "Bay".

The Chesapeake Bay Institute is actively carrying on long-term research of excellent quality.

2) For practical purposes, such as amphibious landings, the Bay has been considered during the last world war as having essentially all types of beaches; and was thus used during the winter of 1943-44 as a training area for amphibious landings to be made in Sicily by the 45th Division and other units, (considered as a model of perfect coordination by General Patton).

3) Additional reasons for making a study based on this area are the exceptional facilities for securing at a minimum cost, ground and air photographs and field data necessary for their interpretation.

"Chesapeake Bay, with its tributaries forms one of the most important waterways on our Atlantic coast". It is an excellent example of an embayment or drowned river on a large scale, and can serve as an example of this coastal feature everywhere in the world. Since it is 170 miles long from its head (the mouth of the Susquehanna River at Havre de Grace) to the Virginia capes, its great size alone almost insures a considerable variety of land forms, vegetation, microclimates and other environmental factors. This is indeed the case.

The sea level in the Bay has changed continually for the last few millions of years. At least four times, i.e. during the warm interglacier periods, the sea level was much higher than

it is now. During the corresponding glaciation periods the sea level was as much as two hundred feet below its present level. A rise of some 200 feet on ocean level is responsible for the drowning of the Susquehanna River whose mouth at the oceanic level was between the Virginia capes.

Since this rise in ocean level was for the most part caused by the melting of the icecap over Canada and the Great Lakes region and Northern Europe, this rise affected many coasts in a similar way to the drowning of the Susquehanna River. For example the Delaware and Hudson rivers, the St. Lawrence, the Baltic and North Seas and even the English channel.

From this it can be inferred that the results of these studies will apply in greater or lesser degree to many other similar embayments or drowned rivers or inland shores elsewhere in the world, and that the keys for interpreting air photographs of this "Bay" can be modified and adapted without much difficulty to other similar areas elsewhere.

Some of the characteristics of drowned rivers and their inland shores are:

1. Sandbars form readily across the mouths of small streams. This is shown in its early stage on photograph 12/6 (at the end of section 4), and in its final stage on Plate VII.

2. Drowned rivers accumulated soft dark mud in their centers but have sandy shores while other rivers have a channel scoured clean and often have muddy banks (flood plains).

UNIFORMITY OF THE LANDFORMS AND THEIR ASSOCIATED TYPES OF VEGETATION IN THE CHESAPEAKE BAY.

Inspection of air photographs and maps, as well as field studies, leads to the conclusion that for our practical purposes, the shores of the "Bay" can be conveniently considered under a few classes of landforms. These are:

1. Points, more or less roughly triangular, jutting rather abruptly out from the general shore line. (Plate VI, 1/5 (shows 4 points), 12/6 (shows 8 points).

2. Coves, more or less sharply concavely, incurved (10/5, 11/5, 12/5, 14/5).

3. Banks forming relatively straight or slightly curved shore lines. (Pl. VII, VIII, photographs 1/5, 11/5, 12/5, 14/5, 12/6).

The surface layer of sediment of each one of these landforms naturally corresponds to the velocity of the medium that dropped them. Thus where the current is slowest, the finest sediment is dropped, i.e. in coves all of which have a relatively flat mud bottom, and a permanently wet, muddy soil on their

shores. In contrast, the current is stronger moving past points which are also much more exposed to wave action. Further, on points the area between tides is steeper, the particles laid down larger, the percentage of sand, higher.

The types of vegetation that corresponds to these landforms are remarkably uniform in so far as they appear on air or ground photographs throughout the whole area of the Bay, and especially in regards to what these types of vegetation indicate as to the height of the water table or water level, the principal factor in trafficability.

So conspicuous and so uniform is this association of types of vegetation with landforms that an inspection of a series of small-scale air photographs even without the great assistance of a stereoscope or even of a magnifier, will enable the photo-interpreter to form a fairly accurate estimate of the terrain conditions. Thus, he can recognize at once and interpret

Points -- relatively sandy and with firmer terrain.

Coves -- relatively muddy and with softer terrain.

Next the interpreter can recognize bands of vegetation in consecutive order on each one of these landforms, each band of vegetation signifying a small difference in height of water-table. Thus between the landforms and their zones of vegetation

with practically no knowledge of botany and without even recognizing any individual trees and bushes, the interpreter can form a fair idea of terrain conditions, especially the trafficability. If, now the interpreter will study the diagrams 4, 5, 6, 7, and 8 in section 5, he can form a clear idea of what is indicated by each zone of vegetation on each landform. If the interpreter will study the Keys in Section 5, page 11, the methods of photo-interpretation outlined in Section 6 for using the tables in Section 7, he can confirm his findings as to terrain conditions and make an even more detailed interpretation. By referring to the plates and photographs as indicated in the text, the interpreter can acquire sufficient practice and experience to interpret air photographs of the Bay and similar areas elsewhere.

It should be noted here that 132 coves in the Chesapeake Bay examined by the author,(in many cases photographed)all showed the same general pattern of vegetation. Coves at the head of creeks anywhere in the "Bay" all show very similar vegetation to the zones of vegetation on Plate X. A similar number of points examined showed an even more uniform pattern of zones of vegetation. (See q on Plate VI, sandbars on Plate VII, 3730 on Plate VIII, 3738 and 3740 on Plate IX and the point on photograph 1/5).

Marshes and Swamps are often formed by Sandbars
Sealing off smaller Tributaries, Creeks, etc.

This is a characteristic of a drowned river, evident on even small-scale air photographs (see page 3).

Just as glacial lakes are prevailingly elongated, so are the marshes and swamps of a drowned river elongated. Both are caused by the damming of a creek or river valley, the first by a terminal moraine, the second by sand bars. These long, relatively narrow marshes and swamps, extending at a wide angle to the drowned river are in marked contrast to the long marshes on the flood-plain, which are roughly situated parallel to the rivers which are not drowned.

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IS A CHEMICAL DIFFERENCE IN THE SOIL SHOWN CONSPICUOUSLY
BY THE VEGETATION ON AIR PHOTOGRAPHS ?

Are there not at least some coves and points in the Bay which are decidedly different in their vegetative patterns and related landforms, especially where these landforms are fashioned out of outcrops of rock chemically very different from the prevailing sandy points and muddy coves? Surely great chemical differences in soil are reflected in great differences in the

associated vegetation?

At the specific suggestion of the monitors of this project, an exploratory study of this matter was made in so far as the time and facilities at our disposal made this possible. The results follow:

a) The shores of the Chesapeake Bay are almost entirely surfaced by unconsolidated sediments; viz, gravel, sand , silt and clay. So very small a fraction of the total area is surfaced by hard rock, either limestone or ironstone, as to be virtually negligible for most military purposes. No volcanic or other crystalline rock appears at the surface of this region until much further inland, i.e. at the "Fall Line", where the first rapids or falls appears.

The fact that these unconsolidated sediments are all of a common marine origin, all slope gently from northwest to southeast partially explains the uniformity of both landforms and their related zones of vegetation.

b) Since the surface material of all points and coves, is to a large extent, recently transported material, the local older marine sediments could hardly be expexted to show much effect through the deep layers of mud and sand resting on them. Nor do they.

c) The average annual rainfall of forty inches, rapidly leaches out lime and magnesia and other soluble salts in all soils locally, so that the rainfall also tends powerfully to obliterate chemical differences in the soils and thus to make them chemically uniform. This also helps to explain the uniformity of land forms and associated vegetative patterns.

d) The deficiency in calcium (lime) salts in all these soils is, as everywhere, associated with a relatively high acidity (low pH) of the soil water which causes leaching out of iron and manganese salts from the upper layer and deposition of iron hydroxides (rust) between the grains of sand in the subsoil to form a hard, solid, impervious layer of hard-pan called locally "iron-stone".

e) Where this iron-stone is close to the earth's surface, (within a few feet) its principal effect seems to be the formation of a raised or perched water-level or water-table. The effect of this water-logging is readily recognizable on the vegetation. The effect of abundance or surplus of iron in the soil water in such localities is negligible certainly in so far as recognizing this effect on air photograph. The perched water-table always has an effect recognizable on air photographs.

If the layer of iron-stone is very close to the surface and the layer of soil thin (and therefore the water-holding capacity small) the vegetation instead of showing the effect of a water-logged or bog condition, will show the effect of the opposite condition, i.e. lack of water. This can be seen on air photographs by the great preponderance of the trees and shrubs characteristic of such a semi-desert soil, e.g. the black-jack, post and rock oaks (Quercus marilandica, Q. stellata and Q. Prinus L.) (see the woods on the point on photograph 1/5 where these three oaks make up nearly all of the woods on the thin layer of soil above the iron-stone).

f) Since no photographic effect of this abundance of iron and manganese could be found where iron-stone is near or practically at the surface, the effect of limestone or shell near the surface which should yield an abundance of lime salts in the soil water, was next investigated. Since lime salts are so readily leached out and downward, only limestone and shell at the surface were considered. The largest shell mound along the Atlantic Coast (and possibly in the world) at Pope's Creek is estimated at having been some thirty acres or more in extent. The vegetation on such mounds, just like those so common on the coast of

Florida reflect in their thin covering vegetation, the abundance of lime salts and the usually very dry soil, since the shell mounds are so very porous they retain very little of the rainfall, e.g. on Pope's Creek there is common, a small bush, the Hop-tree, (Ptelea trifoliata L.) having a trifoliate leaf very similar to that of poison ivy. It does not occur locally except on the shell. As it is small and grows in the shade of larger trees and so can scarcely be seen on vertical photographs, it has no practical use in photo-interpretation.

On many of the local shell mounds, the deficiency of water has a much greater effect than the abundance of lime. On the Florida mounds, the prickly pear cactus is common with a thin scattering of lime-loving trees, shrubs and vines. On low lying piles of shell, such as near an old oyster house, the effect of the abundance of lime is shown in the increased percentage of lime-loving plants, The trafficability of such areas is similar to that of a gravel bed which has also an excessively drained soil and hence good dry footing even in wet weather.

An outcrop of ancient limestone rock made up almost entirely of fossil marine shells forms an outcrop on the Virginia shore of the Potomac River near Fredericksburg,

(opposite Nanjemoy on the Maryland side). Most of the native vegetation on the soil above the limestone has been removed so that there is little evidence of the effect of the rock on plants. A prevalence of black locust is perhaps noteworthy.

SERPENTINE BARRENS.

g) Since there is no crystalline rocks on the Bay shores, a short exploratory study of such an area was made in the serpentine barrens west of Baltimore. Because this rock is very different chemically and gives rise to a very characteristic thick clay soil stubborn and often useless for farming, it was thought such an area would show great differences in vegetation detectable even on vertical photographs. Unfortunately attempts to obtain vertical air photographs of this region failed. However ground photographs (Plates I, II, III and 3684 on V) show quite clearly that where this crystalline rock comes close to the surface, it does have a remarkable and conspicuous effect on the vegetation.

As shown on and described on Plates IV to V serpentine rock the world-over, results in a heavy clay soil which supports a scattered, stunted scrub-like vegetation. The lower photograph on Plate V gives some idea of the size of the masses of this usually dull olive gray-green rock as it occurs on

some islands in Hudson Bay where indeed it sometimes constitutes an entire island. The nickel deposits in Finland and adjacent U.S.S.R. occur in serpentine rock, similar in geological age and general appearance to the Canadian rock. Where the serpentine is at, or very near the surface, at least in the sub-arctic, it may be expected to have a specific effect on vegetation detectable on air photographs. However, like limestone (e.g. on the north bank of the Straits of Belle Isle, where Harold St.John has pointed out the small effect limestone has on vegetation when the rock is covered by a thin layer of soil) unless virtually at the surface, serpentine may have small effect on vegetation.

The great deposits of nickel ore on New Caledonia also occur in a large area of serpentine. The heavy clay soils that have resulted from it cause a marked inhibitory or stunting effect on the vegetation which is plainly visible from an airplane flying over this area (unpublished statement by F.R. Fosberg to the Project Director) and therefore on vertical air photographs. [Plates IV and V show the scattered, desert-like vegetation in this area.]

Returning to the serpentine barrens of Maryland, the stunting of the vegetation and other effects are sometimes attributed exclusively to the poisonous effects of chemical ions

dissolved from the rock, such as chromium, nickel, a great excess of magnesium ions, etc. As a matter of fact, the most conspicuous effect seems to be starvation caused by insufficient water, where there is only a very thin layer of soil over the rock, and the vegetation is desert-like, just as in the case of the iron-stone when it is near the surface (see the preceding page 10). Since a number of plants, e.g. blackjack oak, post-oak, etc., are common to both such dry areas, lack of water rather than specific or poisonous chemical composition seems to be the cause. However, there are a number of small plants found only on these serpentine barrens, but they are of very little practical use in photo-interpreting, e.g. Talinium, etc.

Such areas of thin soil over underlying rock of any chemical composition, close to the surface on any sloping ground usually turn dry soon after a rain, and are therefore to be considered as trafficable in almost any weather. When the layers of serpentine, like the iron-stone are a foot to a few feet below a level surface, they may be sufficiently impervious to cause a perched water-table, a water-logged soil and therefore more or less of a marsh, with the terrain conditions that accompany a marsh.

STEEP BANKS

Steep banks, such as those shown on Plate VII ground and air photographs, Plate VIII, 3731, are very common on shores of the Bay, and often form practically vertical cliffs from twenty to over one hundred feet above the water level. These are military obstacles of considerable importance. The celebrated Marye's Heights at Fredericksburg is an example of such a steep bank. Ten thousand casualties for the Union Army against nearly none for the Confederate Army, in a few minutes, demonstrated what a formidable military obstacle, such as a cliff can be, even to the politician-general who ordered this blundering massacre, an outstanding example of ignorance in evaluating terrain conditions.

LOW BANKS

Low banks often have a steep, almost vertical cliff, sometimes six to twenty feet above the high-water mark. Since they consist of unconsolidated sediments, sands, silts and clays, they are, like berms on a beach, difficult for even tracked vehicles to ascend since the loose sediments slide down readily under the moving tracks.

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ILLUSTRATIONS OF PART II.

PLATES I to V : Serpentine Series. Photographs of vegetation on a soil of a chemical composition extremely different from the unconsolidated sediments close to the Bay.

PLATES VI to X: Landing and other terrain conditions on inland shores. Test Location: Chesapeake Bay Region.

SIX OBLIQUE PANCHROMATIC AIR PHOTOGRAPHS:
Illustration of combined use of landforms and types of vegetation.

Panchromatic Stereo-photographs of the Serpentine Barrens near Delight, Md. Taken at noon in late winter (3165, March 1, 1951) and in late summer (3686, Aug. 27, 1952)

Plates I, II and III are views of an area where the consolidated rock is at the earth's surface or is covered with only a few inches of soil. Such areas are on distinct slopes or flat tops of hills or mountains. They can be recognized on air photographs by their intricate, irregular pattern of grassland interlocking with thickets and stunted woodlands; the grassland indicating the thinnest covering of soil, the driest terrain and the best trafficability in rainy or dry weather, the greatest fire hazard, the poorest facility for entrenching or making fox-holes or concealment, the absence of breeding places for blood-sucking insects and a complete absence of protection. The woodlands indicate moister soil, not quite so dry a terrain, not quite so good a trafficability, less of a fire hazard, much more facility for concealment and for making foxholes and for obtaining protection. The weathered pieces of serpentine (1), the patches of snow, pure white against the black bark of the oak (2), the sunken road (3), the broom grass (B) forming 90% of the grass-vegetation, the blackjack oak (Q) 95% of the tree vegetation, a scrub pine (P) and sassafras (S) are all indicated.

Panchromatic Stereo-photographs of the Serpentine Barrens near Delight, Md. Taken at noon in late winter (3166, March 1, 1951) and in late summer (3685, Aug.27, 1952)

On the rather steep slope of the hill shown on Plate I. The weathered serpentine, the local rock(1) is very conspicuous; the blackjack oak (Quercus marilandica)(Q) by far the commonest tree on these barrens, shown especially at the left, is stunted, gnarled, crippled or killed by fire, lack of water and possibly by toxic traces of minerals from the serpentine. A typical specimen is the leaning tree at the extreme right on the winter view of Plate I, the same tree as in the left of the summer view. The pure white patch of snow forms a nearly 100% contrast with the bark of this tree which has the blackest bark of any tree in this area, a character of great use in identifying it in winter photography. It is always an indicator of water-starved vegetation, dry soil and good trafficability if slope is disregarded. The scrub pine (P), the sassafras (S) and the broom grass (B) are indicated.

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Panchromatic Stereo-photographs of the Serpentine Barrens near Delight, Md. Aug. 27, 1952. Taken at noon with deep yellow (Wratten G) filter, 3687, 3688.

In the gulleys of the serpentine barrens some soil accumulates and makes possible the growth of such drought-resisting trees as the black-jack oak (Q) the sassafras (S) and the wild black cherry (the short bushes in the gulley of 3688). This last photograph is shown to demonstrate how detrimental to intelligence is too dark printing. Compare it with its lighter duplicate. No.3687 demonstrates the great value of using a deep yellow (Wratten G)filter as a means of distinguishing yellowish green foliage (S) from dark green (Q) and this in spite of the very high gloss of the blackjack leaves (Plate I, 3686) in contrast to the low gloss of sassafras. The elusive character of aluminum painted objects in photographs is shown by the wraith-like tower of the high tension line(4). Broom-grass(Andropogon)(B) is 90% of the grass

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SERPENTINE BARRENS

PLATE IV

The chemical composition of the soil can sometimes be inferred from a vegetation which is scant in spite of an abundant rainfall. This may be caused by excessive drainage or adverse chemical composition of the soil or both. A common example of this is the serpentine barrens, the world over, e.g. as here in the tropics of New Caledonia. From "Vegetationsbilder" by Karsten und Schenck.

b) Das Tontouta-Tal im südlichen Serpentin-Massiv mit xerischem Sklerophyllen-Gebüsch und in Talnischen geschützt stehenden Wäldchen.

a) Mageres, offenes Serpentingebüsch vom Berge Poume auf der gleichnamigen Halbinsel, einem isolierten Serpentinstock der Südwestküste im Norden Neu-Caledoniens.

SERPENTINE BARRENS

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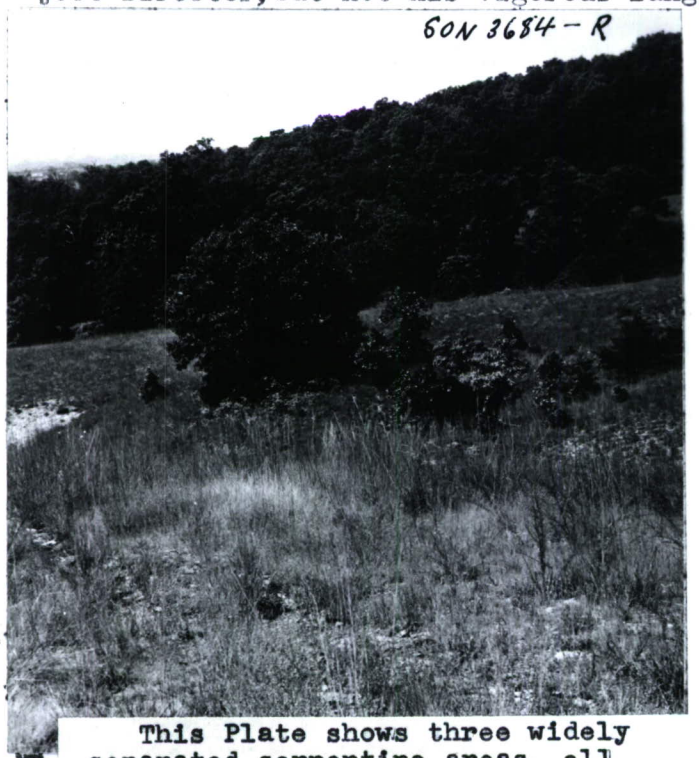
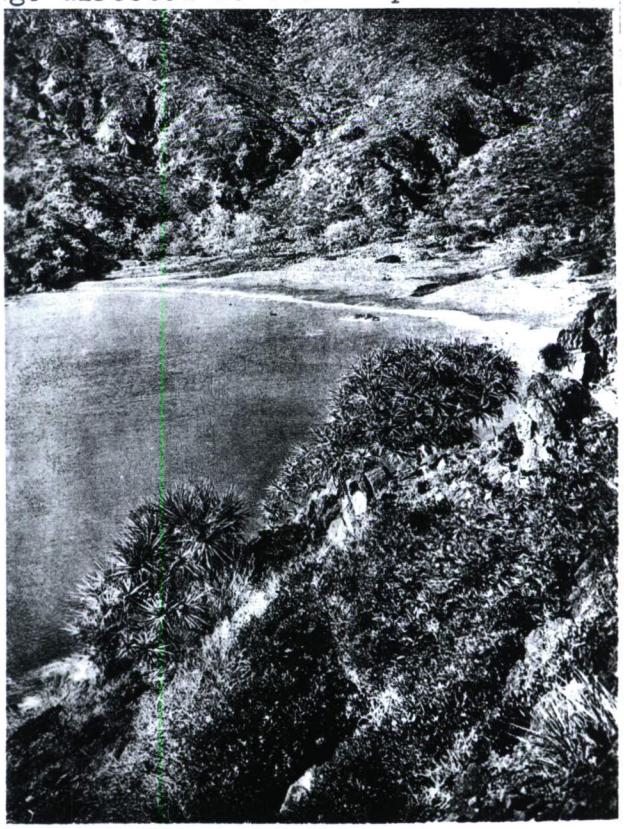
PLATE V

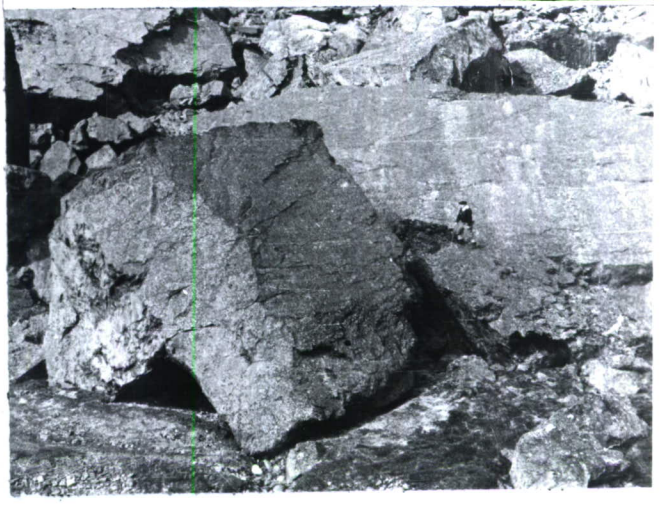
Serpentine, a hard, often dull olive green crystalline rock often weathers to a soil which is resistant to plant growth. Here is shown the desert-like vegetation on a tropical beach, New Caledonia. Lower photograph shows immense fragments of serpentine wedged off a cliff on Gilmore Island in the Arctic Climate of Hudson's Bay, Sept. 1939. The tramp-like silhouette shows the Project-Director, but not his vigorous language directed at the mosquitoes.

GON 3684-R





a) Küstengebüsch der NO-Küste der Serpentin-Insel Yande (nördlich von Neu-Caledonien). REPRODUCED FROM KARSTEN AND SCHENK VEGETATIONSBILDER.



This Plate shows three widely separated serpentine areas, all characterized by the same aspect, that is, relatively much more scant vegetation than the surrounding areas with soils derived from other types of parent rock. The right photograph shows the coast of the small serpentine island, Yanda, north of New Caledonia. The upper left shows a summer view of the serpentine barrens at Soldiers' Delight shown on Plate I, II and III. The outcrop of pale weathered rock shows plainly especially at the extreme left. About 5% of all trees in the open grassland were blackjack oaks, about 40% scrub pine with a few scattered sassafras. The vegetation on the small Ottawa Island in Hudson's Bay near the east shore is very sparse and scant, reflecting the severe climate, the thin sparse coat of obdurate soil from the weathering of the serpentine.

KEEP WIDE MARGIN

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PLATE VI

Terrain Conditions Deducible From Landforms and Vegetation in the Chesapeake Bay. A Sandy Point, Broome's Island, Patuxent River. Stereo Panchromatic Air Photographs, Prod. Market. Adm. AHS 7-118,117. Apr. 20, 1938, Ground Photographs, Sept. 18, 1952. (Plate VII Shows the steep, high, eroding bank of the opposite shore.) approx. 1/17,000

Deductions: "According to our generalizations points (q) always offer firmer sandier terrain than mud-buttomed, coves and their marshy banks.
2. The light tone of the tip of the point indicates sand, the dark tone (z) black mud.
3. The straight, regular lines on the body of the point indicate land used for crops, therefore not water-logged.
4. The opposite shore (Plate VII) has a nearly vertical cliff.
5. In general the point has the best terrain conditions locally for a landing operation

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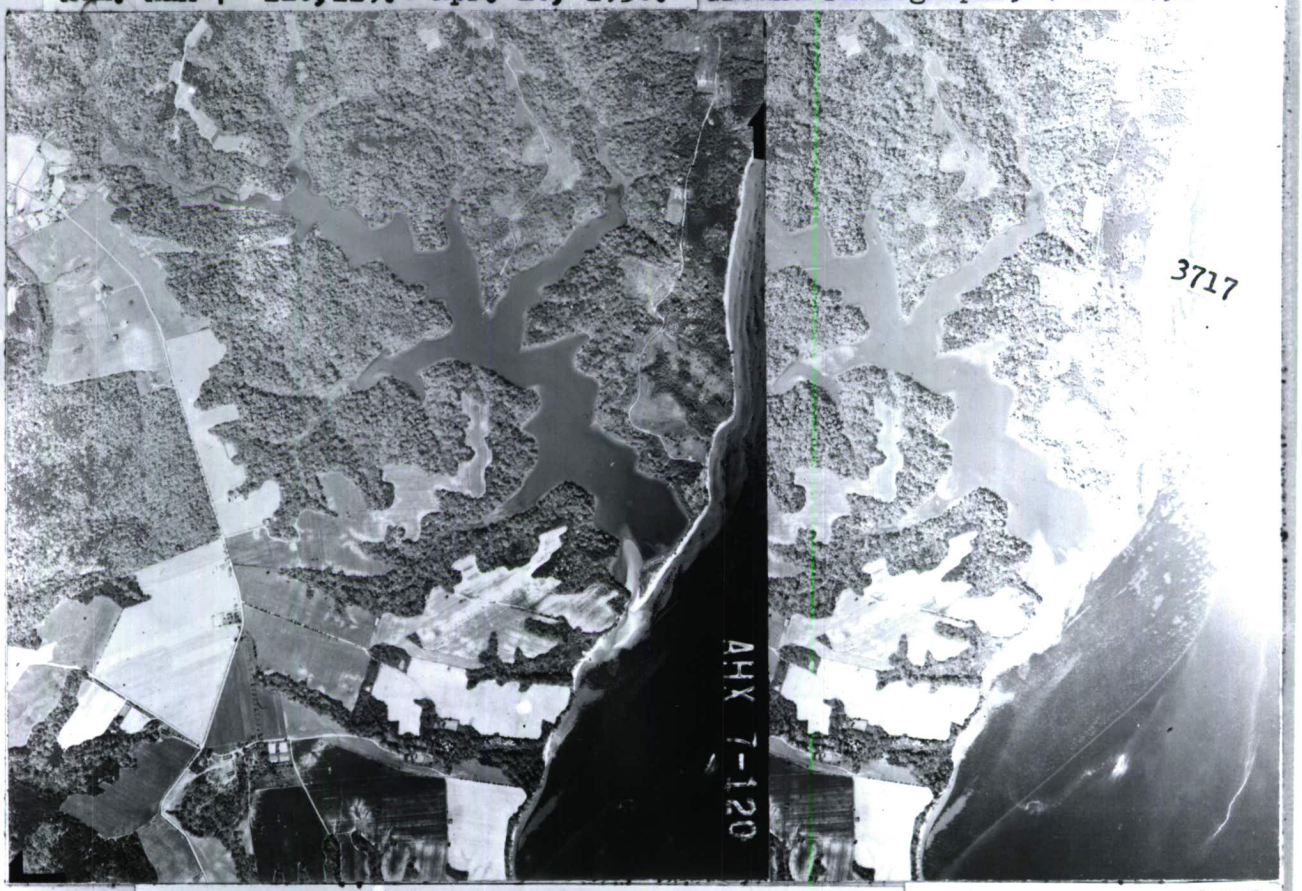
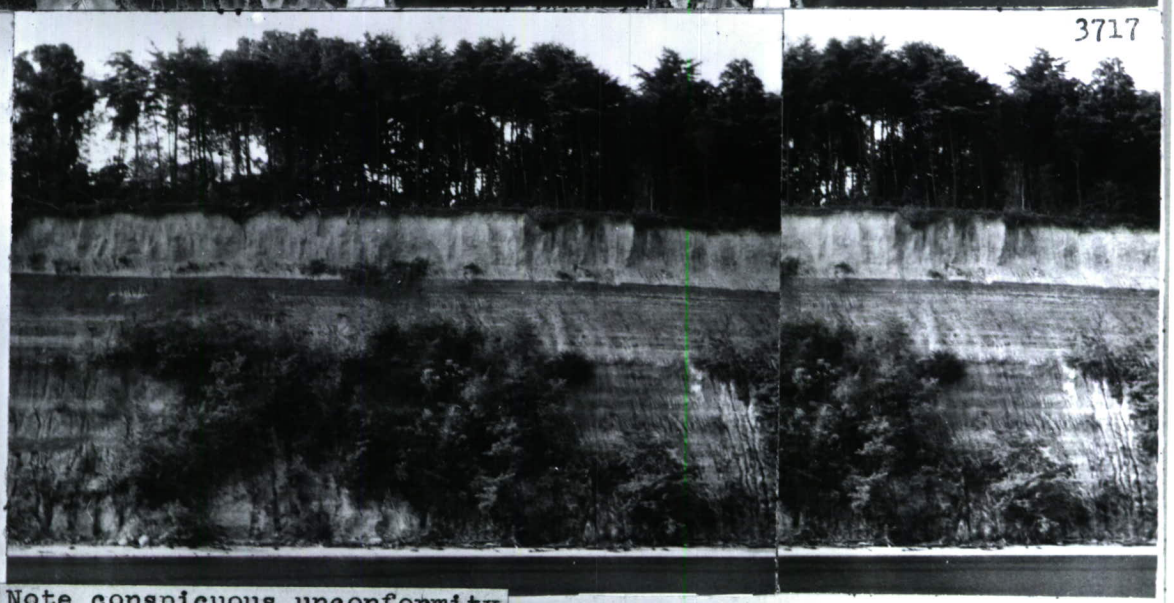
SECURITY INFORMATION

PLATE VII

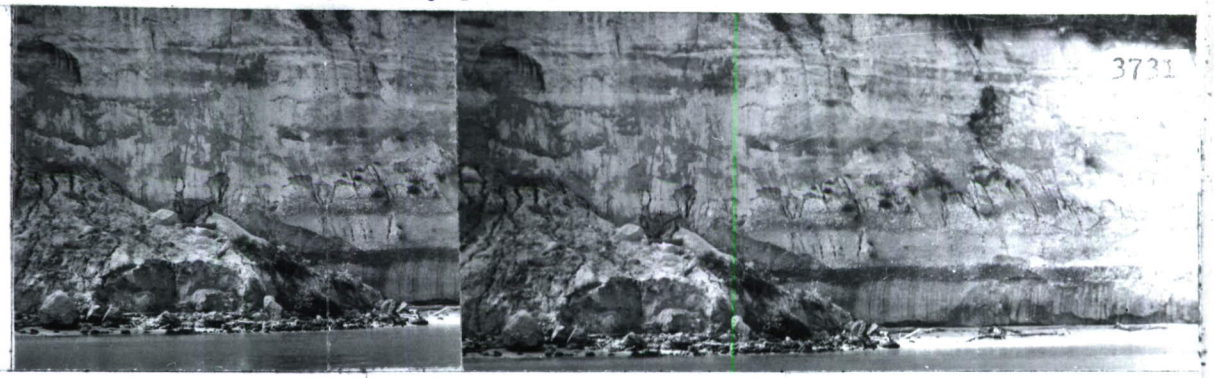
Nearly Vertical Cliff On the Shore Opposite from Broome's Island.
Panchromatic Vertical Air Photographs, approx. 1/17,000. Prod. Market.
Adm. AHX 7 120,119. Apr. 20, 1938. Ground Photographs, 9/18/1952





Note conspicuous unconformity

Nearly Vertical Cliff On the Shore Opposite from Broome's Island and the Shores of A Tributary Creek, St. John Creek. Stereo Ground Photographs, Sept. 18, 1932. Showing a recent erosion from the cliff; a small southern cypress swamp in a cove; a dry point.



The upper photograph shows a detail of a fall of the unconsolidated sediment of the cliff figured on Plate VII no. 3717 . 3721 shows a small cove which contains a minute cypress swamp, a northern outpost of this common southern swamp tree near its present northern limit of distribution. 3730 shows a point with dry terrain on its top indicated by the Spanish Oaks and a thin fringe of wet terrain at the base indicated by a cypress and a sweet bay.

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PLATE IX

Ground stereo photographs Taken through deep yellow (G) filter.
In drowned rivers and embayments, the mouths of small tributaries gradually develop spits, then sand bars and finally close up forming a sandy shore on the river side but a marsh on the land side. St. John Creek, Patuxent River, Sept. 18, 1952.

This is an example of a small creek where a sandbar has built completely across its mouth forming a cat-tail marsh with fresh water and deep, soft mud on its landward side but with a sandy shore of relatively firm footing on the river side. An observer from a boat or the photo-interpreter could be mislead into thinking that such a sand bar formed across the mouth of a former creek, and at a place where the steep line of cliffs is broken by such a gully-like valley, would be a good route to follow after landing on the sandy shore. The marsh inside the sandbar tells the true state of affairs. The bushes in the foreground, salt myrtle, indicate the presence of brackish water. B: Salt-myrtle(Baccharis)

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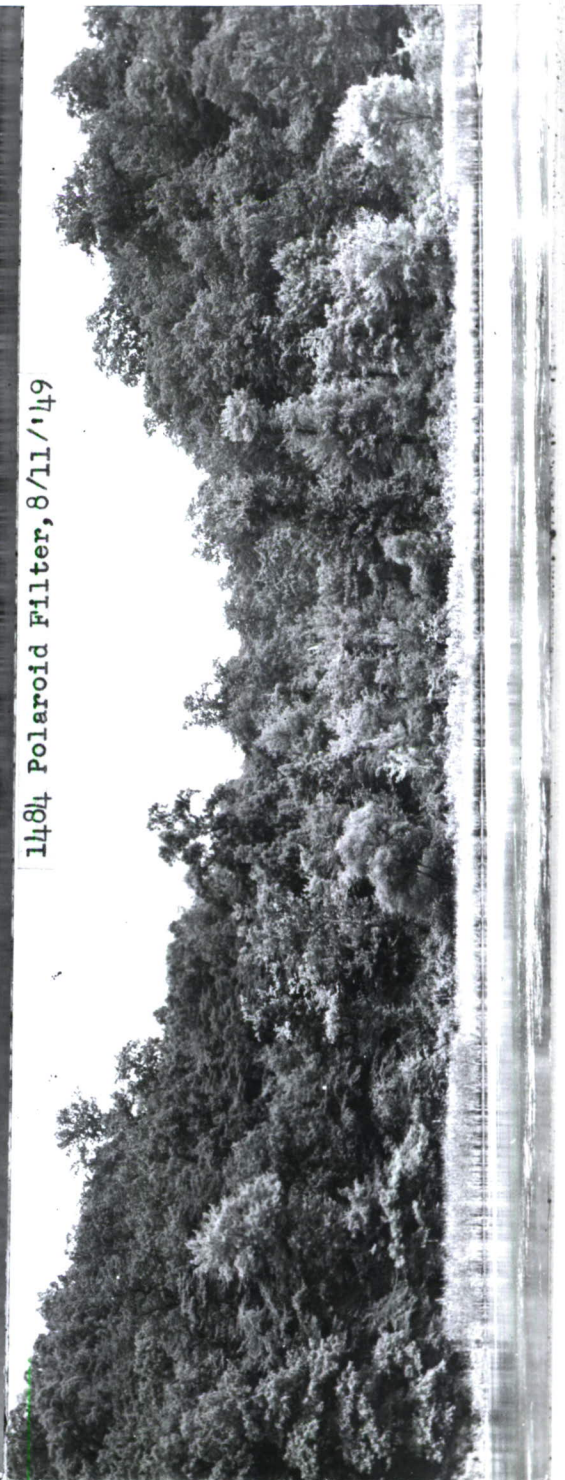
PLATE X

Ground photographs showing zonation, the horizontal line shown by vegetation, the pattern of vegetation shown in coves where the water is brackish, contrast between G-filter and Polaroid Filter. 1476 on oblique air photograph 10/5; 1484 on oblique air photograph 11/5.

1476 G filter Aug.11,1949



1484 Polaroid Filter, 8/11/'49

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(AREA 6)


1087 KODAK AEROGRAPHIC SAFETY
11/5


12/5

5/41

SECTION 5

K E Y S.

Photo-Identification

Keys to aid in the identification of types of Vegetation on Inland Shores.

SECTION 5. PHOTO-IDENTIFICATION.

The principal supplemental addition to Technical Report 1, is probably a new system of deducing terrain conditions by using simultaneously landforms and their related patterns of vegetation in the Chesapeake area. This double method has been used in the making of the following keys.

Further studies in this area in the past two years have shown that there is a remarkable uniformity in the patterns of vegetation that correspond to the landforms in the "Bay". A study of several hundred coves, large and small, in the South River Drainage system showed that all of them had practically the same pattern of vegetation. A corresponding number of points also had a similar uniformity within themselves while the banks connecting them are also fairly uniform in their vegetation in so far as it is possible to generalize for the purposes of photo-interpretation.

In order to make this clear to the interpreter BEFORE HE USES THE KEYS, there follows a diagrams showing the prevailing patterns of vegetation associated with the landforms in areas of:

a) essentially fresh water,

b) brackish water,

c) nearly as saline as seawater.

The landforms, COVE and POINT are readily recognized on air photographs of any, even the smallest scales.

SECTION 5. PHOTO-IDENTIFICATION (continued).

These landforms give a general idea of the terrain, i.e. a point indicates sandy; a cove muddy surface. The details of the terrain of these landforms are most easily deduced from the vegetation patterns which are so uniformly associated with these landforms and WITH EACH OTHER, ALWAYS IN THE SAME ORDER (ZONATION) OF CONCENTRIC OR BANDED ARRANGEMENT, that the interpreter has only to note the relative position and the boundaries of each zone or band recognizable on the air photograph in order to determine the type of vegetation and corresponding terrain conditions, e.g. a cove anywhere in the Bay where the water is brackish (the condition of almost all the Bay), will show either a stand of cat-tails as the first zone of vegetation next to the water or a zone of cord grass with occasionally associated grass-like sedges. This zone indicates the space between the average high and the average low tide levels. The wider this zone, the flatter the inter-tidal band, the flatter the bottom, and more obstructively muddy auch a band of terrain.

The zone of bushes, next vegetation inshore, and bordering the cat-tails or cord grass, always indicates slightly firmer and less deep but still permanently wet soil or mud. These bushes are prevailingly alders in fresh water or in areas of mildly brackish water; but they are almost exclusively salt myrtle and sea-side elders where the water is more salty.

SECTION 5. PHOTO-IDENTIFICATION (continued).

The zone of trees next inland from the bushes is equally important as an indicator of less moist terrain.

The following set of diagrams of typical landforms and their associated patterns of vegetation is more or less closely typical of hundreds of coves and points of the Bay.

Below is the list of symbols for the different plants represented in the diagrams:

Trees and Shrubs (Bushes) i.e. Plants with Woody Stems.

Symbol	Botanical Name	English Name
A	Acer rubrum	Red Maple
Al	Alnus serrulata	Alder
Am	Amelanchier arborea	Juneberry
Ba	Baccharis halimifolia	Salt myrtle
B	Betula nigra	River birch
Br	Broussonetia papyrifera	Paper mulberry
Co	Cornus florida	Flowering Dogwood
D	Diospyros virginiana	Persimmon
F	Fagus grandifolia	Beech
Hi	Hibiscus moscheutos	Marsh mallow
I	Ilex opaca	Holly
Iv	Iva oraria	Marsh elder

SECTION 5. PHOTO-IDENTIFICATION (continued).

Trees and Shrubs (Bushes) i.e. Plants

with Woody Stems

Symbol	Botanical Name	English Name
J	Juniperus virginiana	Red cedar
Lq	Liquidambar styraciflua	Red gum, sweet gum
L	Liriodendron tulipifera	Tulip tree
Lo	Lonicera japonica	Honeysuckle
My	Myrica cerifera M. pensylvanica, etc.	Bayberry Waxberry " Candleberry
N	Nyssa sylvatica	Black gum
P	Pinus virginiana	Scrub pine
PR	Pinus rigida	Pitch pine
PE	Pinus echinata	Short leaf pine
Pl	Platanus occidentalis	Sycamore
Q	Quercus alba	White oak
QC	Quercus coccinea	Scarlet oak
QF	Quercus falcata	Spanish oak
QMa	Quercus marilandica	Blackjack oak
QM	Quercus Prinus L.	Chestnut oak(Q.montana Willd.)
QS	Quercus stellata	Post oak
QV	Quercus velutina	Black oak
R	Robinia pseudoacacia	Black locust
S	Salix nigra	Black willow
Sm	Smilax rotundifolia	Devil's Shoe-string
Ss	Sassafras albidum	Sassafras

SECTION 5. PHOTO-IDENTIFICATION (continued)

Trees and Shrubs (Bushes) i.e. Plants with Woody Stems

Symbol	Botanical Name	English Name
T	Toxicodendron radicans	Poison ivy
U	Ulmus americana	White elm

Herbs, i.e. Plants with Non-woody Stems.

Symbol	Botanical Name	English Name
amM	Ammophila breviligulata	Beachgrass
mi	Mikania scandens	Climbing hempseed
n	Nuphar advenum	Spatterdock
ny	Nymphaea odorata	Water lily
pV	Panicum virgatum	Switch grass
pg	Phragmites communis	Reed grass
pn	Pontederia cordata	Pickerel weed
soJ	Solidago juncea	Early goldenrod
soS	Solidago sempervirens	Seaside goldenrod
sp	Spartina alterniflora	Cord grass, salt water (tall)
spC	Spartina cynosuroides	Cord grass, salt reed (tall)
spP	Spartina patens	Cord grass, salt meadow (short)
t	Typha angustifolia	Narrow-leaved cat-tail (and 3 other species of cat-tail)
x	Xanthium echinatum	Seaside cocklebur
z	Zizania aquatica	Wild rice

Diagram showing the prevailing pattern of vegetation on Coves, Banks, and Points in the Chesapeake Bay region; Brackish water areas.

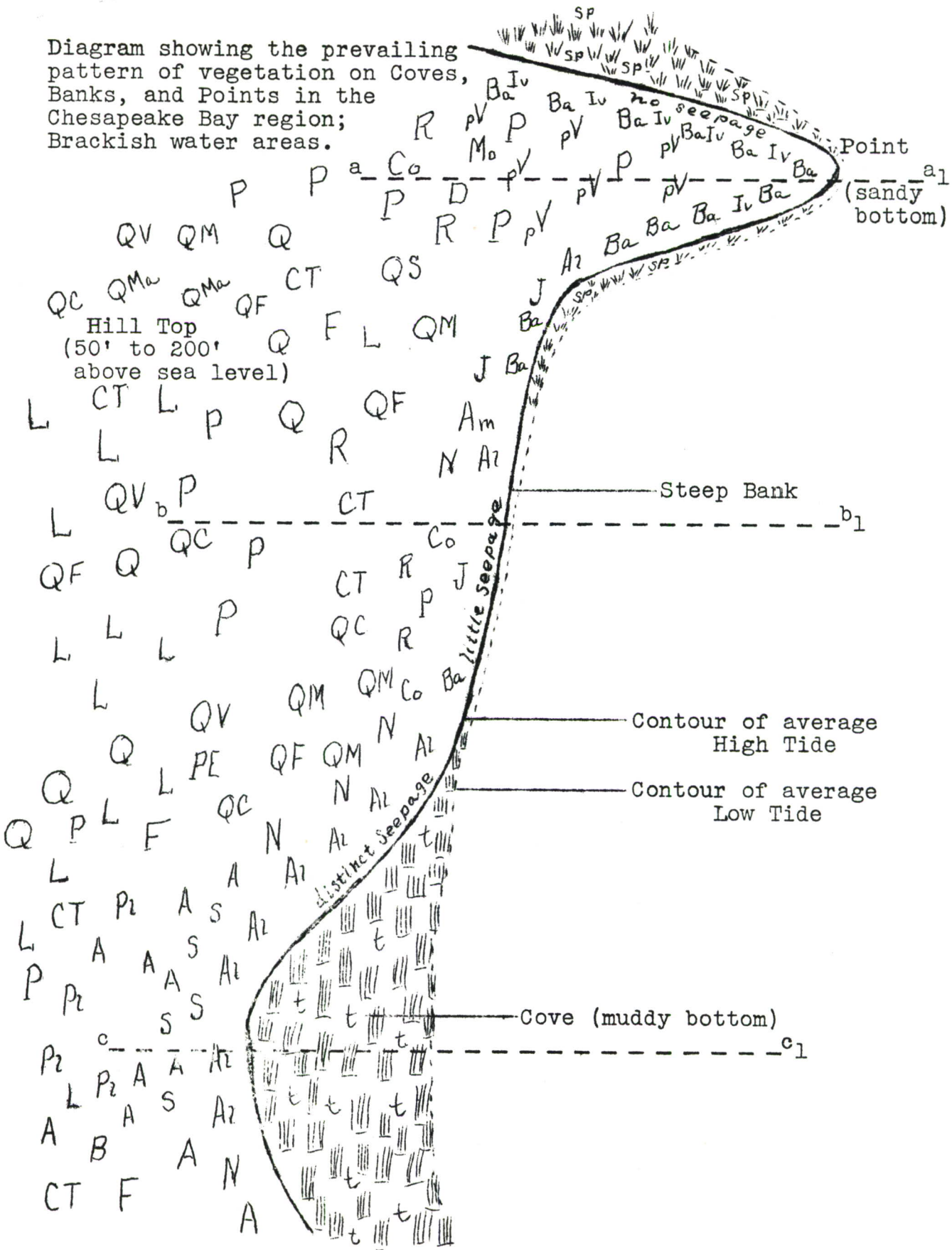


Diagram showing the prevailing pattern of vegetation on Coves, Banks and Points in the Chesapeake Bay Region; Sea water areas.

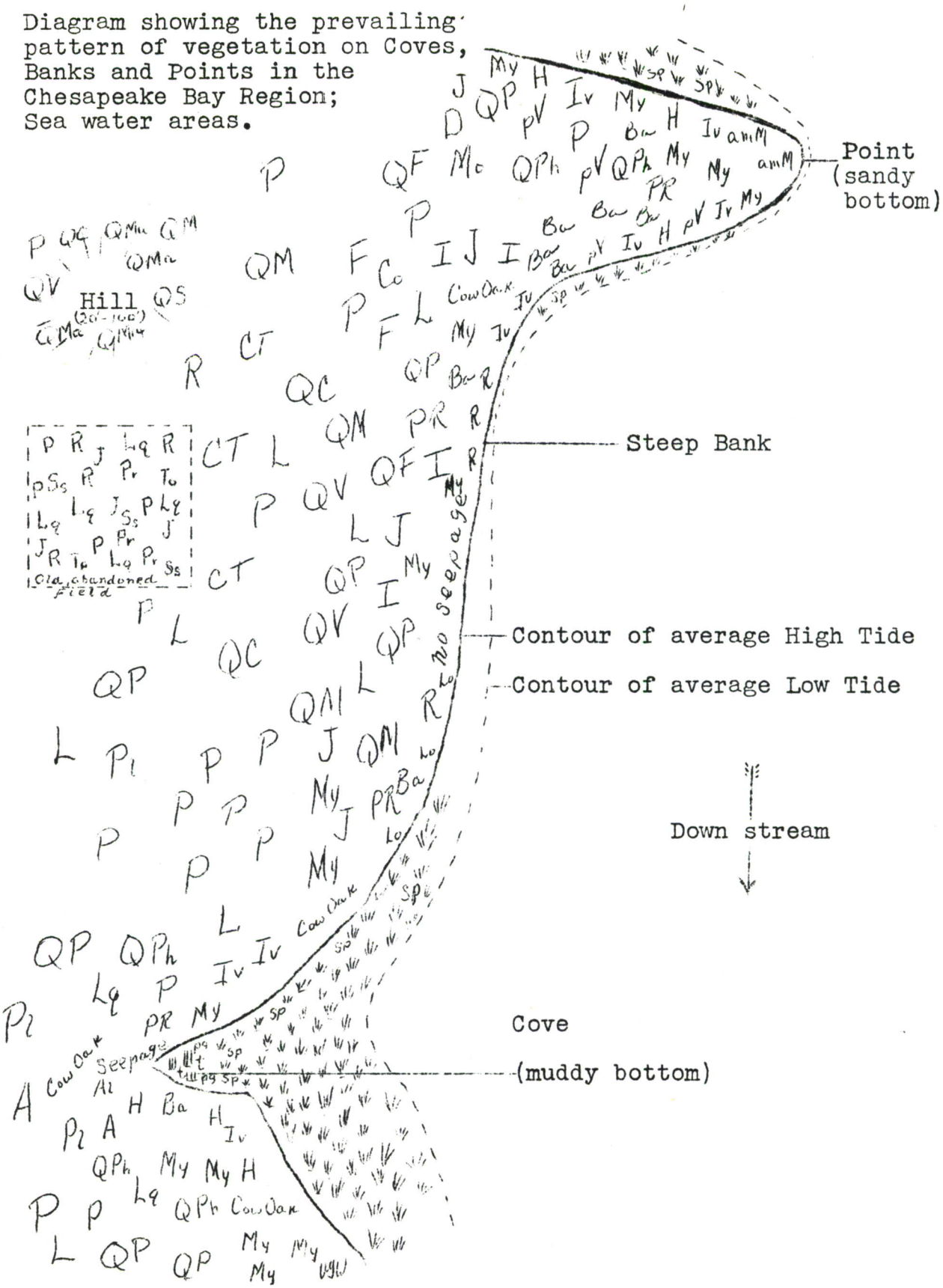
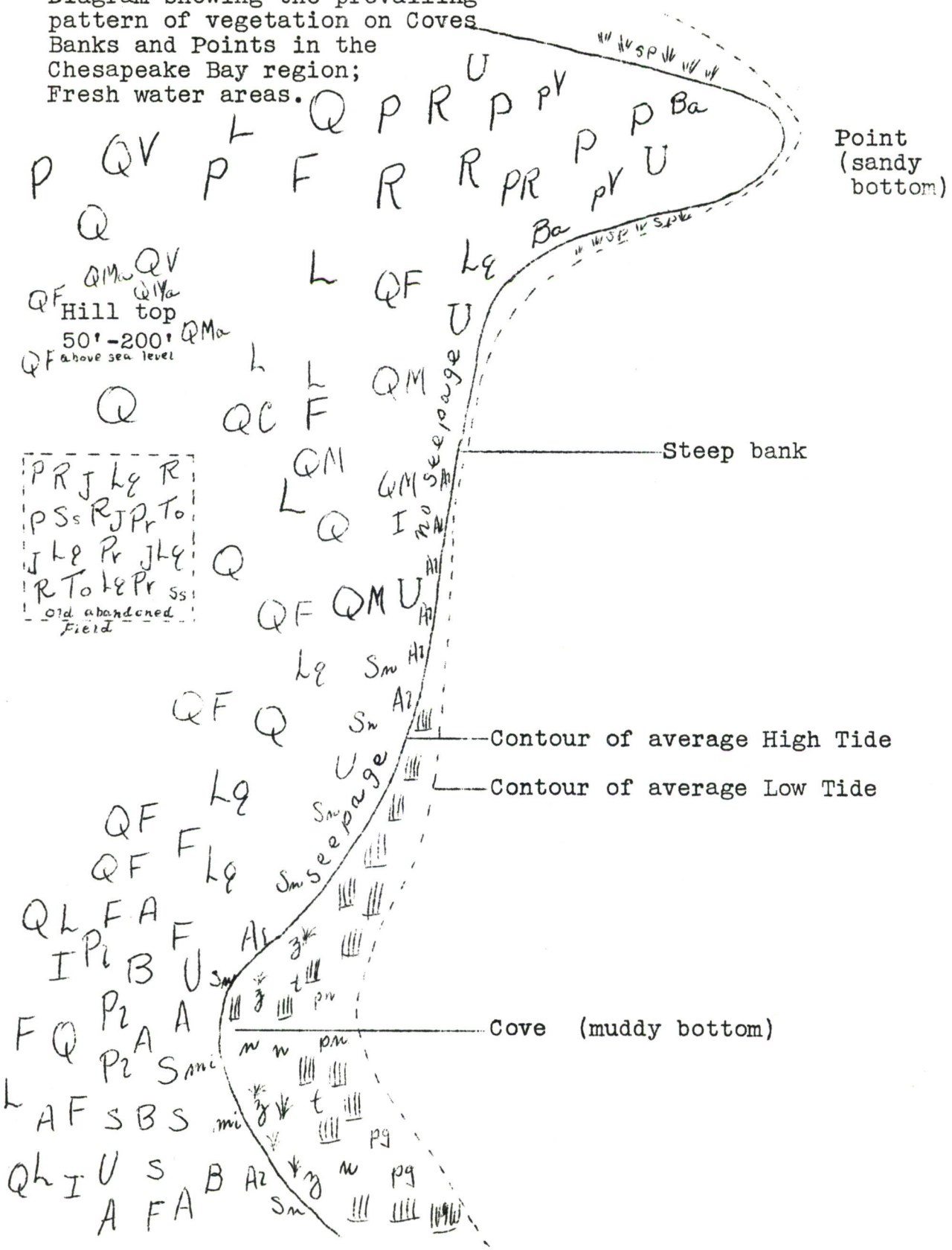
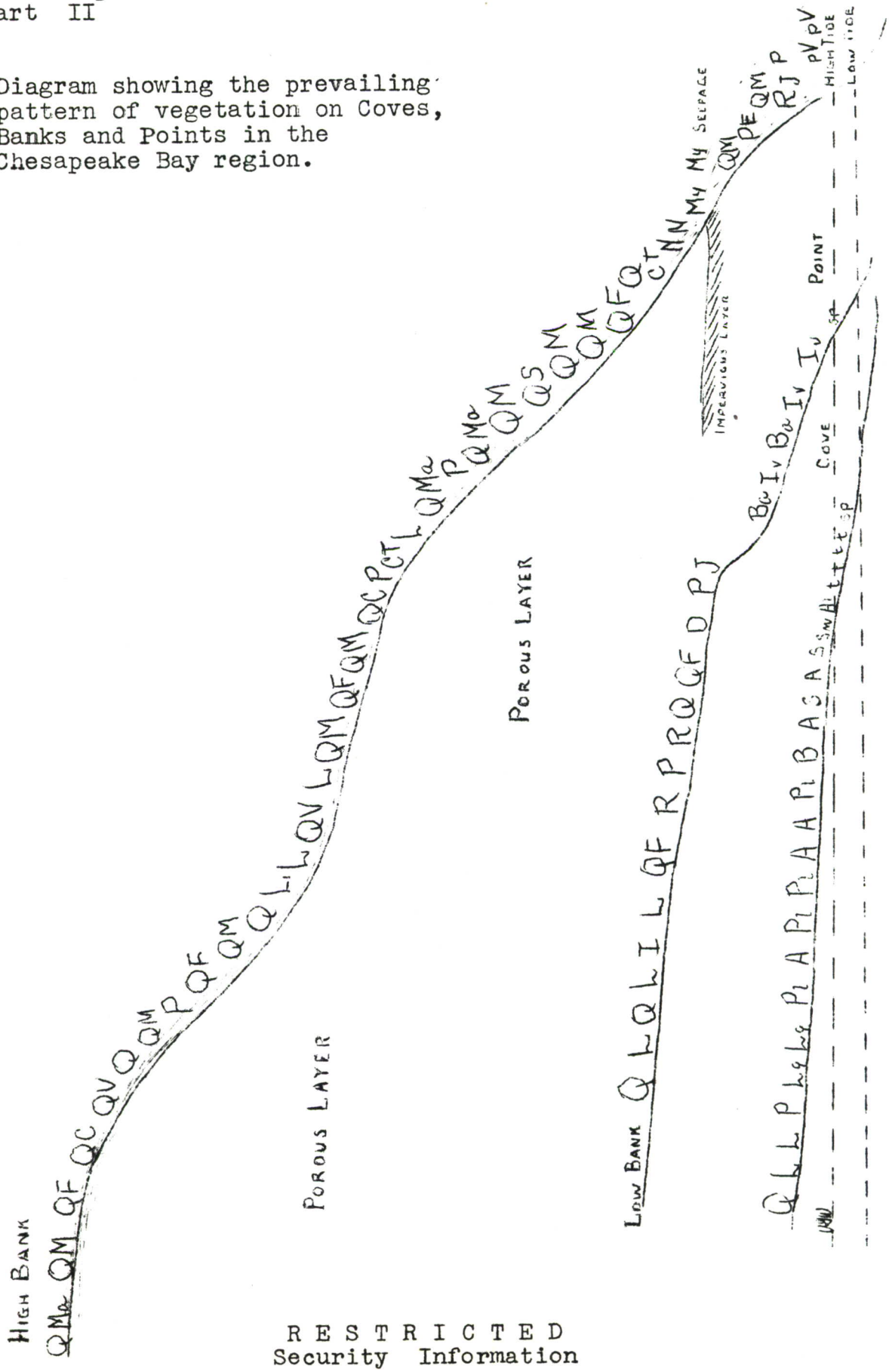


Diagram showing the prevailing pattern of vegetation on Coves Banks and Points in the Chesapeake Bay region; Fresh water areas.



Tech. Rept. 6
Part II

Diagram showing the prevailing pattern of vegetation on Coves, Banks and Points in the Chesapeake Bay region.



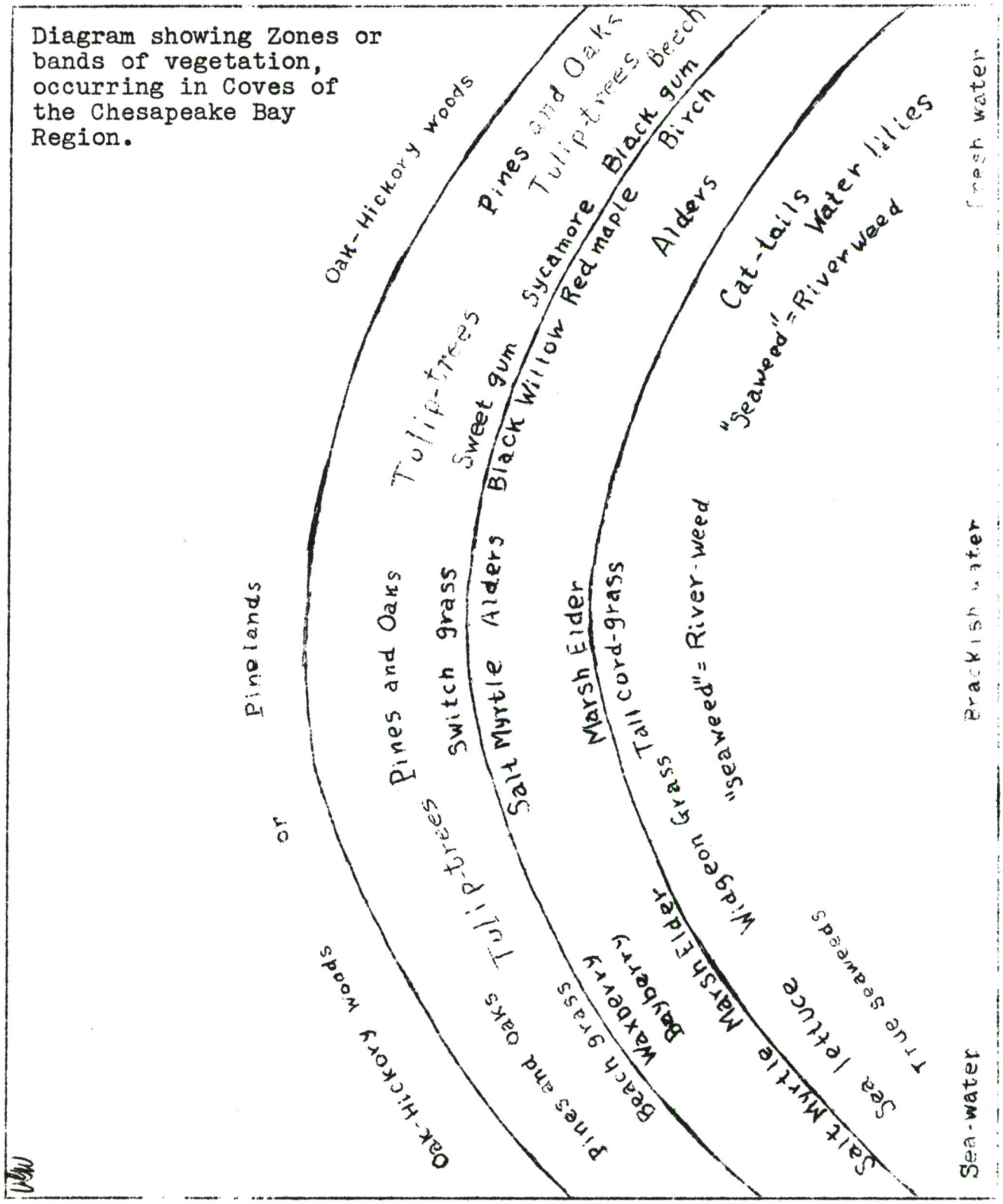


Diagram showing Zones or bands of vegetation, occurring in Coves of the Chesapeake Bay Region.
Oak-Hickory woods
Pines and Oaks
Tulip-trees
Beech
Sweet gum
Sycamore
Black gum
Black Willow
Red maple
Birch
Alders
Cat-tails
Water lilies
"Seaweed"=Riverweed
Fresh water
Pinelands
or
Pines and Oaks
Tulip-trees
Switch grass
Salt Myrtle
Alders
Marsh Elder
Tall cord-grass
"seaweed"= River-weed
Widgeon Grass
Marsh Elder
Salt Myrtle
Oak-Hickory woods
Pines and oaks
Tulip-trees
Beach grass
Waxberry
Bayberry
Sea lettuce
True Seaweeds
Brackish water
Sea-water

From the preceding diagrams the interpreter can form an idea of the prevailing patterns of vegetation in the Bay. The average abundance of any given plant in any zone is expressed roughly in the diagrams by the numbers of times the symbol appears.

One of the great difficulties in making a satisfactory key for recognizing types of vegetation is the great variability in the appearance of any of the plants from season to season. This difficulty was met in the previous Technical Report No. 1 by a system of seasonal keys, i.e. one key for each of six different times of the year. These keys are therefore not repeated here.

Instead a set of new keys based on both landforms and related vegetation is given here. Further these keys are limited in this Report much more strictly to the narrow band of the shores of the Bay and also to masses of vegetation or plant societies rather than to individual kinds of trees or other plants.

Even, with these limitations, it seems necessary to call attention to the multiplicity of keys possible, if all suggestions as to what keys should be made to meet every possible type

of photograph, season, filter, scale, etc. etc. To emphasize this point, there follows a table showing 432 kinds of possible keys, each for its own limited conditions of season, scale, type of photography, etc. etc.

Obviously such a complex of keys is manifestly impractical, more bewildering than useful. Still it was felt necessary to drive this point home in this way in order to make clear why there is not such a plethora of keys included here.

It is presumed that the average photo-interpreter can with common sense and some practice and experience work very well with a very small number of keys and can modify to its own particular problem the keys given here or even make an entirely new key for any particular purpose if and when justifiable.

Here follows the two tables showing 432 kinds of possible keys.

Table of 432 Possible Keys for Specialized Identification of Vegetation on Landforms from Air Photographs of the Chesapeake Bay

Set I Coves

Film	Scale	Water	View	Winter	Spring Early	Spring Mid	Summer	Fall Early	Fall Late
Pan-chrom.	Large	Fresh	Vert.	1	2	3	4	5	6
"	"	Brack.	"	7	8	9	10	11	12
"	"	Sea	"	13	14	15	16	17	18
"	"	Fresh	Obliq.	19	20	21	22	23	24
"	"	Brack.	"	25	26	27	28	29	30
"	"	Sea	"	31	32	33	34	35	36
"	Medium	Fresh	Vert.	37	38	39	40	41	42
"	"	Brack.	"	43	44	45	46	47	48
"	"	Sea	"	49	50	51	52	53	54
"	"	Fresh	Obliq.	55	56	57	58	59	60
"	"	Brack.	"	61	62	63	64	65	66
"	"	Sea	"	67	68	69	70	71	72
"	Small	Fresh	Vert.	73	74	75	76	77	78
"	"	Brack.	"	79	80	81	82	83	84
"	"	Sea	"	85	86	87	88	89	90
"	"	Fresh	Obliq.	91	92	93	94	95	96
"	"	Brack.	"	97	98	99	100	101	102
"	"	Sea	"	103	104	105	106	107	108
Color	Large	Fresh	Vert.	109	110	111	112	113	114
"	"	Brack.	"	115	116	117	118	119	120
"	"	Sea	"	121	122	123	124	125	126
"	"	Fresh	Obliq.	127	128	129	130	131	132
"	"	Brack.	"	133	134	135	136	137	138
"	"	Sea	"	139	140	141	142	143	144
"	Medium	Fresh	Vert.	145	146	147	148	149	150
"	"	Brack.	"	151	152	153	154	155	156
"	"	Sea	"	157	158	159	160	161	162
"	"	Fresh	Obliq.	163	164	165	166	167	168
"	"	Brack.	"	169	170	171	172	173	174
"	"	Sea	"	175	176	177	178	179	180
"	Small	Fresh	Vert.	181	182	183	184	185	186
"	"	Brack.	"	187	188	189	190	191	192
"	"	Sea	"	193	194	195	196	197	198
"	"	Fresh	Obliq.	199	200	201	202	203	204
"	"	Brack.	"	205	206	207	208	209	210
"	"	Sea	"	211	212	213	214	215	216

Table of 432 Possible Keys for Specialized Identification of Vegetation on Landforms from Air Photographs of the Chesapeake Bay

Set I Coves

Film	Scale	Water	View	Winter	Spring Early	Spring Mid	Summer	Fall Early	Fall Late
Infra	Large	Fresh	Vert.	217	218	219	220	221	222
Red	"	Brack.	"	223	224	225	226	227	228
"	"	Sea	"	229	230	231	232	233	234
"	"	Fresh	Obliq.	235	236	237	238	239	240
"	"	Brack.	"	241	242	243	244	245	246
"	"	Sea	"	247	248	249	250	251	252
"	Medium	Fresh	Vert.	253	254	255	256	257	258
"	"	Brack.	"	259	260	261	262	263	264
"	"	Sea	"	265	266	267	268	269	270
"	"	Fresh	Obliq.	271	272	273	274	275	276
"	"	Brack.	"	277	278	279	280	281	282
"	"	Sea	"	283	284	285	286	287	288
"	Small	Fresh	Vert.	289	290	291	292	293	294
"	"	Brack.	"	295	296	297	298	299	300
"	"	Sea	"	301	302	303	304	305	306
"	"	Fresh	Obliq.	307	308	309	310	311	312
"	"	Brack.	"	313	314	315	316	317	318
"	"	Sea	"	319	320	321	322	323	324
Triple	Large	Fresh	Vert.	325	326	327	328	329	330
Photo-	"	Brack.	"	331	332	333	334	335	336
graphy	"	Sea	"	337	338	339	340	341	342
"	"	Fresh	Obliq.	343	344	345	346	347	348
"	"	Brack.	"	349	350	351	352	353	354
"	"	Sea	"	355	356	357	358	359	360
"	Medium	Fresh	Vert.	361	362	363	364	365	366
"	"	Brack.	"	367	368	369	370	371	372
"	"	Sea	"	373	374	375	376	377	378
"	"	Fresh	Obliq.	379	380	381	382	383	384
"	"	Brack.	"	385	386	387	388	389	390
"	"	Sea	"	391	392	393	394	395	396
"	Small	Fresh	Vert.	397	398	399	400	401	402
"	"	Brack.	"	403	404	405	406	407	408
"	"	Sea	"	409	410	411	412	413	414
"	"	Fresh	Obliq.	415	416	417	418	419	420
"	"	Brack.	"	421	422	423	424	425	426
"	"	Sea	"	427	428	429	430	431	432

Keys for the Recognition of Types of Vegetation and related Landforms on Air Photographs.

(Note: These keys are made to assist in recognizing types of vegetation, or individual trees or shrubs. When the type or plant has been identified, the interpreter should turn to the tables of Section 7 in order to make his photo-interpretation.)

Each Key will consist of two to four parts in the following order of landforms: I. Coves.

II. Points.

III. Steep, high banks.

IV. Low banks.

KEY FOR SMALL-SCALE VERTICAL AIR PHOTOGRAPHS.

I. COVES.

1 Zone of water 2

1a Zones of vegetation on the land 3

2 Water with spots of uniform sizes, about 6" to 12" in diameter (indicate fresh water 1' to 5' deep), (when the photograph was taken at such an angle that the sunlight was reflected into the camera these plants will not show . . . Water-lilies

2a Water with areas of lighter and darker tones, each of irregular size and shape, often appearing as a cloudy or mottled bottom. (generally the paler the bottom the more sandy, the darker the more muddy and overgrown with "seaweed", an efficient clogging agent for propellers of small craft). [Deep water is evenly dark-toned, devoid of patterns]. "Seaweeds".

Key for Small-scale Vertical Panchromatic Air Photographs

3 Zone between the water and the line of bushes on the shore, lighter in tone than the water 4

3a Zones of bushes and trees further inland 5

4 At head of creeks, commonly a stand of . . . cat-tails

4a Toward mouths of creeks and estuaries, commonly a stand of . . . . . Cord-grass
(These two types of vegetation are indistinguishable on small-scale photographs but can be separated on larger and better photography, by slight differences in tone and minute texture varying with the season of the year. Cat-tails indicate deeper, softer muddy bottom; cord-grass sandier bottom).

5 Zone of bushes between the marsh (often cat-tails or cord-grass) and the trees 6

5a Zone of trees, behind the bushes, i.e. further inland . 7

6 Zone of bushes rather dark-toned the year round, most common at the head of creeks, tolerating only slight salinity, indicating soft bottom, permanently wet soil . . Alder zone

6a Zone of bushes lighter-toned than the preceding, with patches of snow-white during the period Sept. 20 to Dec. 1; the pale-toned sandy soil showing through or around the bushes, rare in coves, <u>always</u> present on points. A stand of these bushes indicates sandy soil, and brackish water. . . . Salt myrtle-sea-elder zone.

7 Zone of trees at head of creeks indicating a fresh water muddy swamp of . . . Willows, red maples, birches and sycamores. (Soil permanently wet).

7a Zone of trees in coves at mouths of creeks or on banks of broad, open rivers, indicates sandy soil and a rather dry woods of . . . . Scrub pines, oaks, red-cedars, etc.

II POINTS

(continued on next page)

II POINTS

(continued from page 12)

8 Zone of water around the point (brackish to sea water, no seepage of fresh water occurs at points) 9

8a Zones of vegetation on the land 10

9 Bottom showing through the shallow water very light-toned to practically white . . . . . .Clean quartz sand deposited by the locally strong current and/or wave action. Vegetation negligible (q Plate VI)

9a Bottom showing a dark tone through the shallow water . . . . . Finer sand with some silt and a growth of "seaweed", the local current- and wave-action much less than above, not as firm under foot. Sometimes a zone of cord-grass or sedges grows in this zone. These indicate nearly the same kind of bottom but commonly with more silt mixed with the sand.

10 Zone of bushes, about 5 to 10' tall. . . . . This is the salt-myrtle and marsh-elder zone found on practically every point in the Bay region. (Pl.VII tip of sandbar)

10a Zone of vegetation further inland than the preceding . 11

11 Vegetation of scattered trees and bushes, (sometimes with a grass 3 to 6' tall (switch grass) between the trees but scarcely distinguishable on small-scale photographs). This relatively open woods or thicket will usually show some or all of the following: Very dark-toned, conical red cedar, dark-toned pines, lighter-toned persimmon, locust, etc. in summer. (For other seasonal aspects see Tech. Rep. 1). A long thin strip of this vegetation is on the sandbar(Pl VII)

11a Vegetation a practically solid stand of trees. If dark-toned, a pine woods, if lighter-toned commonly an oak-hickory-tulip woods (See diagrams 4, 5, 6, 7). Both these types of woods cover the uplands on Plate VII where the light-toned oak woods are in conspicuous contrast to the pinelands.

III Steep Banks

(continued on next page)

III Steep Banks

(e.g. Pl. VII and 3731 on Pl. VIII) either show practically no vegetation on the air photograph indicating a very steep cliff or show one or more narrow bands of the same vegetation as that of the points.

However these banks are continually subject to landslides as they are being continually undermined by waves and currents and thus, they have a more "weedy" type of vegetation, i.e. such species as sumac, honeysuckle, locust, are commoner here than on points.

IV Low Banks

commonly have the same vegetation as coves but with the zone of cat-tails or cord-grass or sedges, very narrow or wanting and the alders-zone, and the willow-maple-birch zone narrower than in coves.

Second Key.For Large to Medium-Scale, Oblique Air Photographs: Summer Aspect (on the average about May 21 to Sept. 21, i.e. when nearly all the foliage is green).

I Coves.

1 Zone of water 2

1a Zones of vegetation 3

2 Water with spots of uniform sizes, about 6" to 12" in diameter (indicate fresh water 1' to 5' deep), (when the photograph was taken at such an angle that the sunlight was reflected into the camera, these plants will not show on the film . . . . . Water lilies

2a Water with areas of lighter and darker tones, each of irregular size and shape, often appearing as a cloudy or mottled bottom, (generally the paler the bottom the more sandy, the darker the more muddy and overgrown with "seaweed", an efficient clogging agent for propellers of small craft). [Deep water is evenly dark-toned, devoid of patterns]. "Seaweeds".

[NOTE: "Seaweed" i.e. pondweeds, Elodea (so commonly grown in household aquariums) show darker than a light-colored mud bottom or a deposit of fresh silt where erosion is rapid as on the delta on Photo. 10/5. Dark areas in shallow water are often caused by a deposit of soft black mud (iron sulfide) as in the 2 narrow channels in Photo. 12/5. Again the interpreter should note on Pl. X that a horizontal picture taken through a polaroid filter shows the seaweed as nearly white while the G filter shows the seaweed as light gray.]

3 Zone between the water and the line of bushes on the shore, lighter in tone than the water 4

3a Zones of bushes and trees further inland 5

Second Key.For Large to Medium-Scale, Oblique Air Photographs: Summer Aspect (on the average about May 21 to Sept. 21, i.e. when nearly all the foliage is green). (continued).

4 At head of creeks and at seepages. Photos 10/5, 11/5, 12/5, 14/5, Pl. VIII 3721. . . . . Cat-tail marsh

(Note especially 1484 on Plate X where there is a colony of cord-grass in the center, a foot lower than the cat-tails either side. This indicates a seepage on either side.)

4a Toward mouths of creeks and in estuaries, commonly (Pl. X, 1484 in center) a stand of cord-grass or sedges or rushes.

5 Zone of bushes between the marsh (often cat-tails or cord-grass) and the trees 6

5a Zone of trees, behind the bushes, i.e. further inland . 7

6 Zone of bushes rather dark-toned the year round, most common at the head of creeks, tolerating only slight salinity, indicating soft bottom, permanently wet soil. Photo 10/5 between boat house landing and dead tree fallen in water; Plate X, 1476 at extreme left and extreme right indicating seepages from the high banks behind them . . Alder zone

6a Zone of bushes lighter-toned than the preceding, with patches of snow-white during the period Sept. 20 to Dec. 1; rare in fresh water coves, becoming more common in coves farther down stream as the water becomes more salty and the bottom somewhat firmer (Plate IX). . Salt myrtle-marsh elder zone.

7 Zone of trees at head of creeks indicating a fresh water muddy swamp, and therefore permanently wet soil. (Photo 10/5 a little to left of center on far side of the creek; 14/5 dark-toned, compact-crowned willows at lower right; and Plate X 1476, 1484 where the light-toned willows and red maples can be distinguished from each other by means of the feathery texture and tufted branching of the willow and the more horizontal-line-textured and tuftless red maples . . . . Willows,-red maples, birches and sycamores.

7a Zone of trees in coves at mouths of creeks or on banks of broad, open rivers, indicates sandy soil and a rather dry woods. (10/5, 11/5, uplands). . Pines, oaks, red-cedars, locust, etc.

(continued on next page)

Second Key. For Large to Medium-Scale Oblique Air Photographs: Summer Aspect (on the average about May 21 to Sept. 21, i.e. when nearly all the foliage is green). (continued).

II Points
(continued from page 16)

8 Zone of water around the point (brackish to sea water, no seepage of fresh water occurs at points) 9

8a Zones of vegetation on the land 10

9 Bottom showing through the shallow water very light-toned to practically white . . . . . Clean quartz sand deposited by the locally strong current and/or wave action. Vegetation negligible (q Plate VI)

9a Bottom showing a dark tone through the shallow water . . . . . Finer sand with some silt and a growth of "seaweed", the local current- and wave-action much less than above, not as firm under foot. Sometimes a zone of cord-grass or sedges grows in this zone. These indicate nearly the same kind of bottom but commonly with more silt mixed with the sand. (Photo 12/6, the water at the two "claw-like" bars that will soon close off this creek.)

10 Zone of bushes, about 5 to 10' tall. . . . . This is the salt-myrtle and marsh-elder zone found on practically every point in the Bay region. (Pl. IX, Photo 1/5 on the conspicuous point at the left and 12/6 on the "crab-claw-like points" beginning to close off the creek in the foreground).

10a Zone of vegetation further inland than the preceding .. 11

(continued on the next page)

Second Key. For Large to Medium-Scale Oblique Air Photographs: Summer Aspect (on the average about May 21 to Sept. 21, i.e. when nearly all the foliage is green). (continued).

II Points
(continued from page 17)

11 Vegetation of scattered trees and bushes. (Plate VIII 3730; Photo 1/5 on point at left foreground and on point on far side of creek in middle background). This relatively open woods or thicket will usually show some or all of the following: Very dark-toned, conical red cedar, dark-toned pines, lighter-toned persimmon, locust, etc. in summer. (For other seasonal aspects see Tech. Rep.1). A long thin strip of this vegetation is on the sandbar (Pl. VII).

11a Vegetation a practically solid stand of trees. If dark-toned, a pine woods, if lighter-toned commonly an oak-hickory-tulip woods. (See diagrams 4, 5, 6, 7). Both these types of woods cover the uplands on Plate VII where the light-toned oak woods are in conspicuous contrast to the pinelands. (See also Pl. VII, 3717).

III Steep Banks

See Section 5, page 14.

IV Low Banks

See Section 5, page 14.

SECTION 6

PHOTO-INTERPRETATION METHODS

Photo-interpretation proper by use of Tables.

SECTION 6: PHOTO-INTERPRETATION PROPER BY THE USE OF TABLES AND OTHER INFORMATION.

After the photo-interpreter has identified the land forms and whatever he can in the way of identification of zones or bands of vegetation, and possibly some colonies, stands, groups (or under favorable conditions some individual large size plants) of plants, he can make use of rules, tables, maps and/or any other auxiliary information not on the photograph itself in order to deduce terrain conditions.

For the Chesapeake Area what the common types of vegetation indicate has been listed in the next section (7) as table no. 1. What the individual plant indicates has been listed in the next table no. 2.

Turning to these tables, the interpreter can see what each type of vegetation and what each plant indicates. In summing up these indications and considering them in the light of common sense, sound judgment and all available extraneous information, the interpreter can arrive at a reasonably accurate idea of terrain conditions at any particular location shown on a photograph.

Here is a procedure or method for interpreting photographs of the Chesapeake area. [The interpreter can see that much of this necessarily applies to large coastal areas and embayments elsewhere in the world.]

The following generalizations should be kept in mind at the start.

SECTION 6: PHOTO-INTERPRETATION PROPER BY THE USE OF TABLES AND OTHER INFORMATION.(continued)

1. Trafficability on any shore is mostly the result of currents and wave action.

2. Landforms and prevailing winds give a rough idea of the extent of wave action.

3. Currents move with more velocity past points; with less velocity past banks; and with least velocity or not at all past coves.

4. The size of the particle carried by the current varies directly with the sixth power of the velocity of the current. From this it follows that where the current is faster only the coarser particles are dropped, i.e., at or on the points; but where the current is slower the finer particles are dropped, i.e., in the coves. Hence coves have a soft deep mud bottom while adjacent points have a sandier firmer bottom.

5. Points and coves are easily recognized landforms on air photographs while the banks connecting them have terrain conditions intermediate between that of points and coves.

6. The details of the terrain conditions on coves and points are often best recognized by the zones or bands of vegetation visible on the photograph as concentric or adjacent bands of different tone, texture, etc.

7. The relative width of the bands or zones of vegetation is an excellent index of the very small differences in the degree

SECTION 6: PHOTO-INTERPRETATION PROPER BY THE USE OF TABLES AND OTHER INFORMATION.(continued)

of slope, e.g., the wider the zones or bands, the flatter the slope. As an example, a wide zone of cat-tail marsh indicates a wide zone of mud practically perfectly level from one side to the other as well as a foreshore or flat muddy bottom under the adjacent water, while a very narrow zone of cat-tails, with a zone of alders only a few feet wide next inshore indicates a steeply sloping shore.

8. In the more open parts of the Bay, where wave action is relatively strong everywhere, the difference between coves and points is much smaller. Any considerable wave action produces a sandy beach on any shore, easily recognizable from the very light tone.

Here is an example of the use of the foregoing rules and the following tables in section 7:

The interpreter has recognized the following vegetation from an air photograph of a cove in an area far in the Bay:

A zone of water containing water-lilies, one hundred feet wide and then progressively inland, a five-hundred-foot zone of cat-tails, then a five-hundred-foot zone of alders, then a narrow band of willows, maples and birches less than fifty feet wide, then a similarly narrow band of sycamore trees, then a narrow band of tulip-trees and beechtrees followed by square miles of oak forest.

SECTION 6: PHOTO-INTERPRETATION PROPER BY THE USE OF TABLES AND OTHER INFORMATION.(continued)

Referring to "Water-lily" on page vii of table no. 2, section 7, the interpreter can now write his interpretation as follows:

1. The water is fresh, not brackish.

2. From the width of this zone the bottom must slope very gently.

3. From the land form (cove) and the gentle slope the bottom most likely is coated with deep mud.

4. Next to the water must be an area of soft mud 500' wide, covered with 1" to 6" of water corresponding to "cat-tail marsh" on page 1, table 1, section 7.

5. From page 1, table 1, section 7, troops attempting to cross this area on foot would have to walk or flounder through deep soft mud with no concealment a distance of at least 600' until

6. The zone of alders, also 500' wide, is reached where troops would find concealment.

7. The rate of foot-travel across these zones of deep mud as well as across the five-hundred-foot zone of alders, also on mud bottom (but offering support on the strong intricate system of interlacing roots counterbalanced by the dense system of branches), must necessarily be slow, possibly less than 1/2 mile an hour and extremely exhausting.

SECTION 6: PHOTO-INTERPRETATION PROPER BY THE USE OF TABLES AND OTHER INFORMATION.(continued)

8. By careful inspection the photo-interpreter may notice that there is no trail across the cat-tails, no leaves of the water-lilies turned over or disarranged. This will enable him to deduce that no barbed wire has been placed and no mines have been laid in the cat-tails, except possibly in the natural channels, and that the enemy has most likely considered the cat-tail marsh as naturally so efficient an obstacle as to require no reenforcement of any kind.

9. Also from page 1, table 1, section 7, it can be seen that if any enemy tanks or tractors had made their way through the alders, the tracks would certainly show.

10. Also from the same page, it can be deduced that since both the willow-maple-birch zone and the sycamore and tulip-tree zones are narrow there must be a steep bank here which might not be and actually is often not recognized from the stereoscopic view.

11. In view of the exhausting march through the deep mud of the cat-tail marsh, it might be considered necessary to allow resting time before foot-troops attempt the climb. Similarly, "ducks", "weasels" and other such amphibious vehicles should be warned of the steep slope in the woods behind the alders.

12. Also from page 1, table 1, section 7, the interpreter could hardly expect to find tracks of enemy vehicles or foot troops in the woods, in any of the four adjacent zones, i.e.,

SECTION 6: PHOTO-INTERPRETATION PROPER BY THE USE OF TABLES AND OTHER INFORMATION.(continued)

"willow-maple", "sycamore-red-gum", "beech-tulip" or "oak-pine".

Finally, the photo-interpreter should remember that the identification of zones of vegetation almost always is a much surer indication of terrain conditions than single trees, and that identification of a single tree is seldom of much value unless confirmed by the recognition on the air photo of a number of other trees all indicating the same terrain, e.g., a single black gum, or a single river birch or a single red maple might be identified on the top of a hill. This one tree by itself is of no value in photo-interpretation. But if several of each of black gum, river birch and red maple with a willow and some alders occured together on a hill top, in spite of land forms and topography and geology, the deduction must be made that this hill top is covered with permanently wet soil on a perched water-table.

This is an example of terrain conditions deduced not at all from the land forms, but entirely from the vegetation.

SECTION 7

Tables for Photo-interpretation.

In the following two tables the significance of the various columns is as follows:

In Table no.1

Depth of Water is given in feet or inches at average middle tide.

Conceals refers to the property of the given type of vegetation to conceal a person standing erect.

Tracks of vehicles or foot tracks, Useful signifies that a second vehicle or person on foot will find it easier to travel in the track made than did the predecessor.

Tracks Detectable signifies that these tracks can be seen on air or ground photographs.

In Table no. 2

Marsh or Swamp indicates permanently wet areas.

Water, fresh, sea or brackish indicates the degree of salinity of the bodies of water with which the respective plants are associated.

Waste Place, Dry and Wet indicates the "weedy" nature of the plant, i.e. that it invades abandoned fields, roadsides, trash dumps, railroads, etc.

Table of the Principal Types of Vegetation of the Chesapeake Bay Shores and What Terrain Conditions They Indicate

00: not at all. 0: very slightly. X: decidedly. XX: Outstandingly.

Name of the Type of Vegetation	Depth of Water	Permanently Wet	Conceals	TRACKS VEHICLES Useful	TRACKS VEHICLES Detectable	TRACKS FOOT Useful	TRACKS FOOT Detectable
Fresh-water Coves brackish Coves with fresh-water seepage or creeks sealed off by sand bars							
"Seaweeds" i.e. Pondweeds	1'-5'	XXX	000	--	000	--	000
Water lilies	1'-4'	XXX	000	--	XXX	--	X
Cat-tail marsh - wild rice	1"-6"	XXX	0	00	XXX	0	XXX
Alder-marsh	0	XXX	XX	X	XX	X	00
Willow, red maple, birch swamp	00	XX	XX	X	X	X	00
Sycamore, red gum low woods	00	0	XX	X	XX	X	00
Beech, tulip-tree, woods	00	00	XX	X	XX	X	00
Oak, pine, tulip tree, hickory woods	00	000	XX	X	XX	X	00

Table of the Principal Types of Vegetation of the Chesapeake Bay Shores and What Terrain Conditions They Indicate

00: not at all. 0: very slightly. X: decidedly. XX: Outstandingly.

Name of the Type of Vegetation	Depth of Water	Permanently Wet	Concealment	TRACKS VEHICLES Useful	TRACKS VEHICLES Detectable	TRACKS FOOT Useful	TRACKS FOOT Detectable
Brackish Coves and Points without seepage							
"Seaweeds", widgeon grass, etc.	1'-5'	XXX	--	--	00	--	000
Salt water, cord grass	1"-6"	XX	00	00	X	000	0
Salt myrtle and marsh elder	0	0	X	X	XX	X	00
Pine, locust, holly, red-cedar, dry woods	00	00	X	X	0	X	00
Oak, hickory, pine, tulip-tree, tree woods	00	00	XX	X	00	X	00
Cypress swamps(in southern part of the bay).	1'-5'	XXX	XX	?	00	X	00
Waxberry, bayberry (behind the dunes)	1"-6"	X	X	X	XX	X	00
Switch grass	0	0	X	X	XX	X	0

Tech. Rep. 6
Part II

Section 7
Table no. 2

Table of Principal Plants of the Chesapeake Bay Shores

and

What Terrain Conditions They Indicate.

Trees and Bushes (Shrubs),

i.e. Plants with Woody Stems or Trunks.

00: not at all. 0: very slightly. X: decidedly. XX: outstandingly .

	1	2	3	4	5	6	7	8	9
		WATER			WASTE PLACE			TRACKS (FOOT)	
English Name of the Plants	Marsh or Swamp	Fresh	Sea	Brackish	Dry	Wet	Conceals	Useful	Detectable
Alder	XX	XX	00	X	00	0	XX	XX	0
Ash, spiny	0	0	00	0	X	X	X	XX	00
Ash, white	X	X	00	00	00	00	XX	XX	00
Asp, quaking	X	X	00	00	X	X	X	XX	00
Bay, sweet	XX	XX	0	0	00	00	X	0	0
Bayberry, shorter	X	XX	X	XX	0	X	0	X	0
" taller	XX	00	XX	X	00	0	XX	XX	00
Beech	X	X	00	00	00	00	XX	XX	00
Birch, river	XX	XX	00	0	0	X	XX	X	00
Blackberry	X	X	0	X	XX	XX	0	X	0
Blueberry	0	0	00	00	0	0	00	XX	0

Trees and Shrubs

00: not at all. 0: very slightly. X: decidedly. XX: outstandingly

	1	2	3	4	5	6	7	8	9
		WATER			WASTE PLACE			TRACKS (FOOT)	
English Name of the Plants	Marsh or Swamp	Fresh	Sea	Brackish	Dry	Wet	Conceals	Useful	Detectable
Cedar, red	X	0	X	X	XX	X	XX	XX	00
Cherry, wild black	X	X	00	00	XX	X	X	XX	0
Cornel, silky	XX	XX	00	X	00	0	X	X	0
Devil's Shoe-String	XX	XX	0	X	XX	XXX	X	XX	0
Dogwood, flowering	0	0	00	00	X	00	X	XX	0
Elder, marsh	XX	0	XX	XX	00	00	X	X	0
Elderberry	XX	XX	0	X	X	XX	X	X	0
Elm	XX	XX	00	00	00	0	XX	XX	00
Gum, black	XX	XX	00	X	0	X	XX	XX	00
Gum, red, sweet	XX	XX	00	X	X	XX	XX	XX	00
Hackberry	00	00	00	00	X	X	XX	XX	00
Hickory, mockernut	00	00	00	00	00	00	XX	XX	00
Holly	X	X	00	0	00	X	XX	XX	00
Honeysuckle	X	X	0	X	XX	X	X	XX	0

Tech. Rep. 6
Part II

Section 7
Table no. 2
(continued)

Trees and Shrubs

00: not at all. 0: very slightly. X: decidedly. XX: outstandingly.

English Name of the Plants	1 Marsh or Swamp	2 WATER Fresh	3 WATER Sea	4 WATER Brackish	5 WASTE PLACE Dry	6 WASTE PLACE Wet	7 Concealment	8 TRACKS (FOOT) Useful	9 TRACKS (FOOT) Detectable
Huckleberry	00	00	00	00	00	00	00	X	0
Juneberry	0	0	00	0	X	0	X	X	00
Laurel, mountain	00	00	00	00	00	00	XX	XX	00
Locust, black	0	0	0	0	XX	0	XX	XX	00
Maple, red	XX	XX	00	X	0	X	XX	X	00
Marsh-mallow	XX	X	XX	XX	00	00	X	0	0
Mulberry, paper	00	00	00	00	X	0	XX	XX	00
Myrtle, salt	XX	0	XX	XX	0	0	X	XX	0
Oak, basket	X	X	00	X	0	0	XX	XX	00
Oak, black	0	0	00	0	0	0	XX	XX	00
Oak, blackjack	00	00	00	00	0	0	X	XX	00
Oak, chestnut or rock	0	0	00	0	0	0	XX	XX	00
Oak, pin	XX	XX	00	X	0	0	XX	XX	00

Tech. Rep. 6
Part II

Section 7
Table no. 2
(continued)

Trees and Shrubs

00: not at all. 0: very slightly. X: decidedly. XX: outstandingly.

	1	2	3	4	5	6	7	8	9
		WATER			WASTE PLACE				TRACKS (FOOT)
English Name of the Plants	Marsh or Swamp	Fresh	Sea	Brackish	Dry	Wet	Conceals	Useful	Detectable
Oak, post	0	0	00	0	0	0	XX	XX	00
Oak, scarlet	0	0	00	0	0	0	XX	XX	00
Oak, spanish	0	0	00	0	0	0	XX	XX	00
Oak, white	X	X	00	0	0	0	XX	XX	00
Oak, willow	XX	XX	00	X	0	0	XX	XX	00
Pear	00	00	00	00	X	0	XX	XX	00
Pepperbush, sweet	XX	XX	00	XX	00	00	0	X	0
Persimmon	0	0	00	X	X	X	XX	XX	00
Pine, loblolly	XX	XX	0	XX	X	X	XX	X	00
Pine, pitch	X	X	0	X	X	X	XX	X	00
Pine, scrub	0	0	0	0	XX	X	XX	XX	00
Pine, short leaf	0	0	00	00	0	0	XX	XX	00
Poison-ivy	XX	XX	X	XX	XX	XX	00	X	X
Poplar, white	0	0	0	0	XX	0	XX	XX	00

Tech. Rep. 6
Part II

Section 7
Table no. 2
(continued)

Trees and Shrubs

00: not at all. 0: very slightly. X: decidedly. XX: outstandingly.

English Name of the Plants	1 Marsh or Swamp	2 WATER Fresh	3 WATER Sea	4 WATER Brackish	5 WASTE PLACE Dry	6 WASTE PLACE Wet	7 Conceals	8 TRACKS (FOOT) Useful	9 TRACKS (FOOT) Detectable
Rose, wild or swamp	00	00	00	00	XX	0	0	XX	0
Sassafras	0	0	00	00	XX	0	XX	X	0
Sumac, dwarf	0	0	00	00	XX	0	X	XX	0
Sumac, smooth	0	0	00	00	XX	0	X	XX	0
Sumac, staghorn	0	0	00	00	XX	0	X	XX	00
Sycamore	XX	XX	0	0	X	X	X	XX	0
Tree of heaven	00	00	00	0	XX	0	X	XX	0
Tulip-tree	X	X	00	X	0	0	XX	XX	0
Virginia-creeper	X	X	00	0	X	X	00	XX	X
Walnut, black	0	0	00	00	X	X	X	XX	00
Willow, black	XX	XX	0	X	0	X	XX	X	00
Bald Cypress	XXX	XX	0	X	00	00	XX	X	00

Herbs, i.e. Plants Without Woody Stems

00: not at all. 0: very slightly. X: decidedly. XX: outstandingly.

	1	2	3	4	5	6	7	8	9
		WATER			WASTE PLACE			TRACKS (FOOT)	
English Name of the Plants	Marsh or Swamp	Fresh	Sea	Brackish	Dry	Wet	Conceals	Useful	Detectable
Aster, salt marsh	XX	0	XX	XX	00	0	00	00	XX
Beachgrass, marram-grass	XX	00	XX	X	00	00	00	0	00
Bermuda grass	0	0	00	00	XX	XX	000	XX	00
Broom-sedge	00	00	00	00	XX	0	00	X	X
Cat-tail, 4 kinds	XX	XX	0	X	00	0	0	X	XXX
Climbing-hempseed	XX	XX	00	X	00	0	0	X	X
Cocklebur, seaside	0	0	XX	X	X	X	00	00	00
Cord grass, salt meadow	XX	00	XX	XX	00	0	000	X	X
Cord grass, salt reed	XX	00	XX	XX	00	0	0	X	X
Cord grass, salt-water	XX	00	XX	XX	00	0	00	0	X
Goldenrod, early	00	0	00	00	XX	0	00	0	X
Goldenrod, seaside	XX	0	XX	XX	00	0	00	0	X

Herbs, i.e. Plants Without Woody Stems

00: not at all. 0: very slightly. X: decidedly. XX: outstandingly.

English Name of the Plants	1 Marsh or Swamp	2 WATER Fresh	3 WATER Sea	4 WATER Brackish	5 WASTE PLACE Dry	6 WASTE PLACE Wet	7 Conceals	8 TRACKS (FOOT) Useful	9 TRACKS (FOOT) Detectable
Pickerel weed	XX	XX	00	X	00	X	000	00	X
Pondweed, Sago	XX	XX	0	XX	00	00	000	00	00
Reed-grass	XX	XX	00	XX	00	0	0	0	XX
Rice, wild	XX	XX	00	X	00	0	0	0	XXX
Rush, Roemer's	XX	0	XX	XX	00	00	00	X	XX
Spatterdock	XX	XX	00	00	00	00	000	00	00
Switch-grass	XX	0	X	XX	0	0	0	0	00
Three square	XX	0	X	XX	00	0	00	0	XX
2 kinds Water-lily	XX	XX	00	00	00	00	000	00	00
Widgeon grass (Ruppia)	00	00	XX	XX	00	00	000	00	00